3D PRINTING

NEW ENGLAND FOUNDRY TECHNOLOGIES

WILLIAM SHAMBLEY
President
NEW ENGLAND FOUNDRY TECHNOLOGIES

ARTICLE TAKEAWAYS:

- Expanded design freedom doesn't fix bad geometry
- You'll have the least defects if you adopt the 3D printing process that fits most directly into your existing foundry process
- The wrong materials selection can lead to defects every time
- Not all applications will require the same settings, even on the same printer and materials

One of the most commonly heard reasons that foundries have put off adopting 3D printing, in any format, is the misperception that "it doesn't work." Well, this misperception is sort of like running around barefoot, swinging a tree branch and declaring that footwear doesn't work either. You don't want to wear super insulated duck boots for a summer marathon run, and you can't reliably wear stiletto heels while fishing for striped bass on a jetty.

You have to run the right printing process, use the right kind of materials, and use all the right settings to get defect free castings out of any process. Doing a little up-front simulation work to make sure the casting and rigging are set up right before you even start picking a 3D printing process is an even better idea.

So here's 4 rules of thumb to help you prevent defects when using 3D printing in your foundry:

1. Know your casting - good casting design is good 3D printing casting design. Expanded design freedom doesn't magically fix bad geometry. Take time to run a naked simulation of the casting before you design the tooling to analyze for predicted shrinkage or porosity defects. Tools like SOLIDCast exist substantially to help us understand our castings better and prevent all manners of defects right at the outset. Use 3D printing to build rigging for all kinds of interesting solutions after you've decided where the problems are.

2. Match your processes - the various 3D printing processes match up better to some casting processes than others. These days, there are mountains of information available from the AFS, manufacturers of 3D printing systems, universities, service providers, etc. There are charts to help you decide which process to use based on part complexity, number of parts in a run, existence of tooling, and part size. To keep it really simple, try this: What process fits into your daily operation? If you blow cores, you can use core boxes printed out of plastic or metal. Investment casting? You can print waxes on several printers, based on your surface finish, ash, shell and speed requirements. Ramming green sand, no-bake, etc. with hand or machine? Yes, you can 3D print plastic or metal tooling on a variety of systems – some with more hand work than others. Or print sand cores. Or synthetic sand cores. Or print molds. You'll have the least defects if you adopt the 3D printing process that fits most directly into your existing foundry process. Unless you're really ready to take a leap forward. Then go with something like the SLM Solutions equipment and print fully dense metal parts directly from CAD.

Continued on next page

3. Know your printer materials - Most 3D printing processes can run a range of materials these days. Lower cost systems like those by Lulzbot and Ultimaker work well with a range of PLA, PC, ABS plastics, and even with some highly flexible rubber filaments. Higher-end printers like those from Stacker expand that range of plastics, as well as speed and build envelope. Top shelf printers like the pellet fed systems from Titan 3D Robotics can use an extremely wide range of engineering plastics, even high temperature materials and carbon fiber reinforced filaments.

Among the tooling grade materials there are softer plastics for extrusion style printers like PLA which are low cost, print quickly, and work well in most environments. Harder materials such as PEKK and PEEK or glass/fiber filled resins cost more, and are more tricky to print, but can be machined or polished to a smoother surface, resulting in much better casting quality and longer tooling life.

3D printers have come a long way past plastic extruders, and direct metal printers like the SLM can print metal tooling for continuous green sand, DISA or diecasting lines, applications which would never be considered with polymer-based tooling. Care should be taken in these cases not to pick 3D printing materials that are harder than the rest of the tool, as sometimes this can lead to premature tool wear.

Materials to make investment casting waxes are available for extrusion processes as well as Binderjet and DLP/SLA. A metal caster faces process tradeoffs between speed, surface quality, accuracy and cost. Consultation with the manufacturer about specific materials is your best bet to match printed waxes to your current shell materials. The wrong materials selection can lead to defects every time.

Sand printers have materials choices as well these days. Furan binder on silica sand is still the most common combination but ceramic and synthetic sand options are widely used as well. These options can become quite useful solutions for projects with complex cores. The accuracy of sand printing has progressed to the point that foundries are now using 3D printed sand cores to eliminate dimensional defects formerly associated with manual assembly. Just like with standard no bake sand casting, making the right selection of sand and resin will help prevent casting defects.

4. Know your settings - all manufactures have claims, and all systems have realities. Build settings like scaling and tool comp get applied differently from one style of printer to the other. Part orientation, style of support structures, wall thickness all varies. Are you going to be adding a high build primer? Sanding down the ridges? Assembling lots of pieces with threaded inserts? Not all applications will require the same settings, even on the same printer and materials. You wouldn't buy a half million-dollar CNC machine and only put one tool in the rack, would you?

While there is not room in this article to get into all the details but properly set up parts in the build volume and dialing in the settings is one discipline that has a major impact on 3D printed part defects. Experienced operators make a world of difference. Investing in training is a great way to get started but using the technology as much as possible helps your whole team approach the next problem with more savvy. I always advocate for having folks do projects that they are invested in (hence all my 3D printed fishing lures and garage organizers). Experimentation in non-critical path projects is a great way to learn new ways to apply the tools.

There are so many foundries using 3D printing now that uttering "it doesn't work" is tantamount to saying, "I like my head in the sand pile!" Educating yourself on when to use which materials, in which 3D printing process, and making sure that all the settings are dialed in right will substantially reduce costly defects. Just make sure you're making a good casting at the very beginning of the workflow.

Contact:
WILL SHAMBLEY
will@nefoundrytech.com